

From Green Power to Red White and Blue

Workshop on Interconnecting Distributed Energy

12 December 2001 - Honolulu, HI

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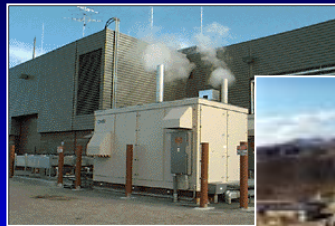
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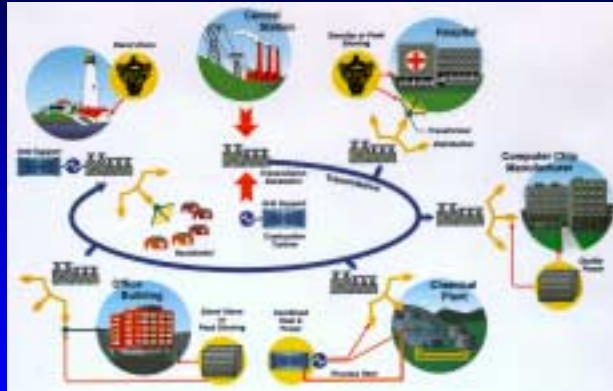
Distributed Energy Technologies



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What is Distributed Energy?



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DE Technologies

- Fuel Cells
- Micro-Turbines
- Advanced Reciprocating Engines
- Wind Power
- Photovoltaic Power
- Geothermal Power



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DE Applications

- Stand-alone
- Emergency back-up
- Combined heat and power
- Peak shaving
- Grid support



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Customer Benefits

- Power quality, **security**, and reliability
- Flexible power for a wide range of loads
- Environmentally sustainable
- Reduces energy cost volatility in a deregulated market



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Contractor Benefits

- Limits capital exposure and risks
- Minimal T&D investment
- Equipment flexibility
- Fuel flexibility
- Lower environmental compliance costs



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National Benefits

- Helps meet environmental goals
- Better suited for rapidly growing world energy market
- Establishes a multi-billion dollar per year industry for continued economic growth
- Decreases dependence on foreign energy



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Priority After September 11th

Energy Security

- Force Protection
- Homeland Defense



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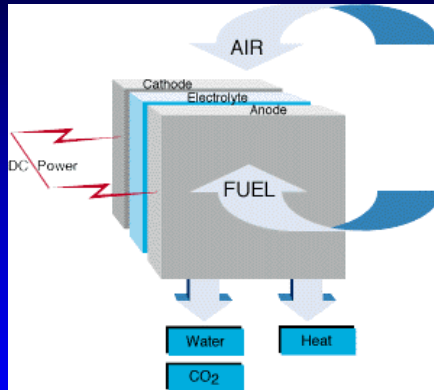
Fuel Cells



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Fuel Cells



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Fuel Cells



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Fuel Cells

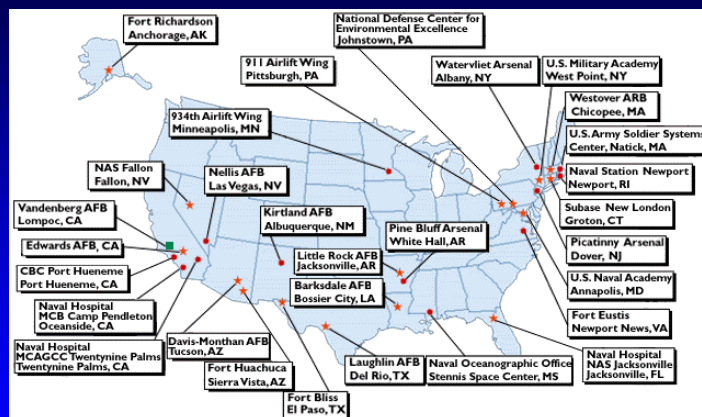
- Just one commercial product available today but many are due in the next few years
- Quiet, no emissions, high efficiency
- Very reliable, high-quality power - currently expensive, \$3000/kW, but could fall as low as \$100/kW in mass production
- Many sizes, from laptop power supply to megawatt scale



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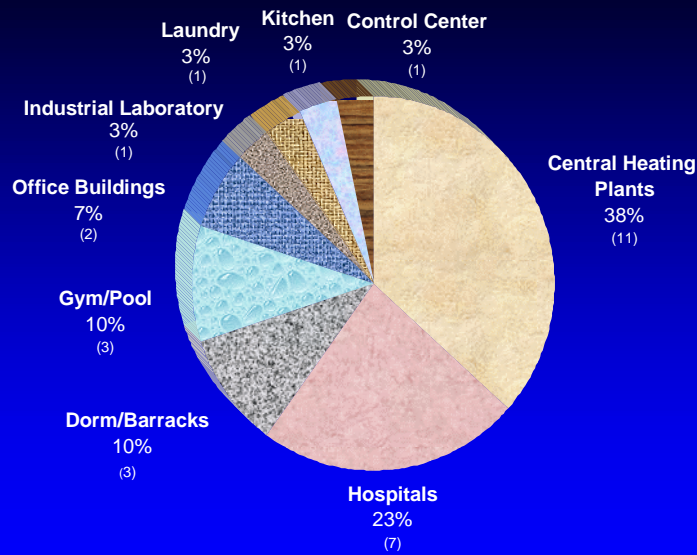
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DoD Fleet Building Applications



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Fuel Cells

Further advancements include...

- Development of molten carbonate, solid oxide, PEM, and alkaline technologies
- Development of vehicle applications will impact mass production, which will lower costs further



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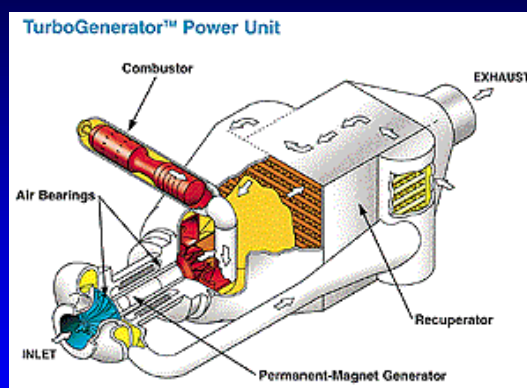
Micro-Turbines



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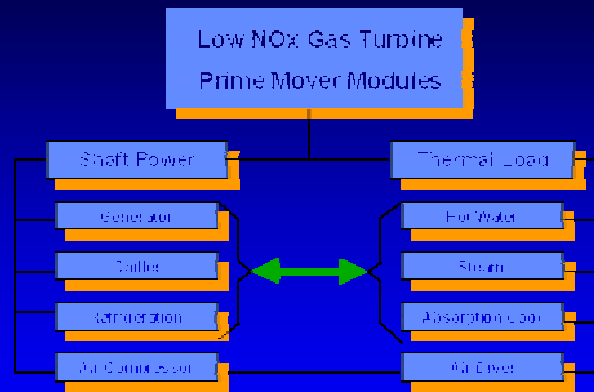
Micro-Turbines



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Micro-Turbines



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Micro-Turbines

- Miniature versions of combustion turbines widely used by utilities and co-gen developers
- Vehicle as well as facility applications
- Higher efficiency and lower emissions than reciprocating engines
- Multiple fuels



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Micro-Turbines

- Range from 30-kW units to a few hundred kilowatts
- One moving part - reduced maintenance
- First commercial models available in 1999
- Market entry prices approximately \$600/kW, projected below \$400/kW
- Product infrastructure support unproven



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Micro-Turbines

Further advancements include...

- Establish support infrastructure
- Investigate and demonstrate units that are currently being commercialized



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Advanced Reciprocating Engines



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Advanced Reciprocating Engines

- Established technology with global infrastructure support
- Used in nearly all natural gas powered generators less than a megawatt
- Mass produced by many companies
- New packaged and small commercial co-gen systems



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Advanced Reciprocating Engines

- Many sizes, from 5 kW to megawatts
- Drawbacks - emissions, noise, and relatively high maintenance
- \$500-\$1500/kW
- Less efficient than micro-turbines



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Advanced Reciprocating Engines

Further advancements include...

- Monitor performance in comparison to conventional diesel generators
- Feasibility of converting existing diesel gen-sets to ARE



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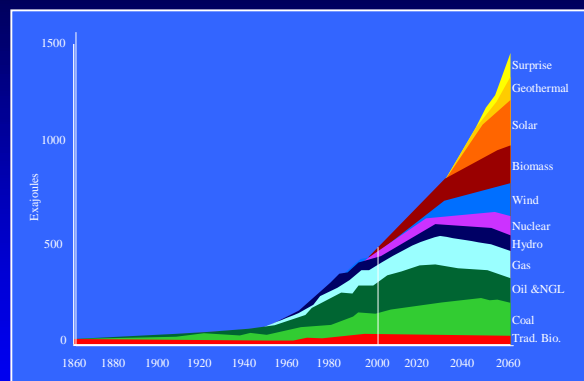
Renewable Distributed Energy



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Renewable Distributed Energy



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Wind Power



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Wind Power

- Renewable energy technology - no fuel costs
- No environmental pollutants or thermal signature
- Low maintenance
- Sizes as small as 50-W to as large as windfarms generating hundreds of megawatts



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Wind Power

- Many commercial products available
- Global infrastructure support
- Drawbacks - high initial costs
\$1500-\$2000/kW



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Wind Power

Further advancements include...

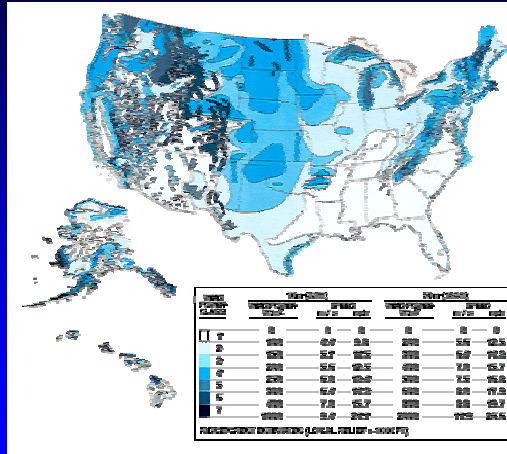
- Demonstrate the most recently commercialized technologies with improvements in turbine and blade design that allow the system to generate power at lower wind speeds, opening up much larger geographical areas where wind turbines will be effective



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Wind Power



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Wind Power



- Establish a regional framework through state and local partnerships
- Accelerate technology development
- Provide Federal leadership in wind power use
- Educate the American public



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Wind Power

Goals...

- Provide at least 5% of the nation's electricity with wind by 2020
 - more than 5,000 megawatts will be installed by 2005
 - over 10,000 megawatts will be on-line by 2010
- Double the number of states which have more than 20 megawatts of wind capacity to 16 by 2005, and triple the number to 24 by 2010
- Increase wind's contribution to Federal electricity use to 5% by 2010



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Wind Power

Benefits...

- Adding \$60 billion in capital investment in rural America over 20 years
- Reaching \$8 billion in annual investment by 2020
- Providing \$1.2 billion in new income for American farmers, Native Americans, and rural landowners over 20 years
- Displacing 35 million tons of atmospheric carbon in 2020
- Creating 80,000 permanent jobs in 2020



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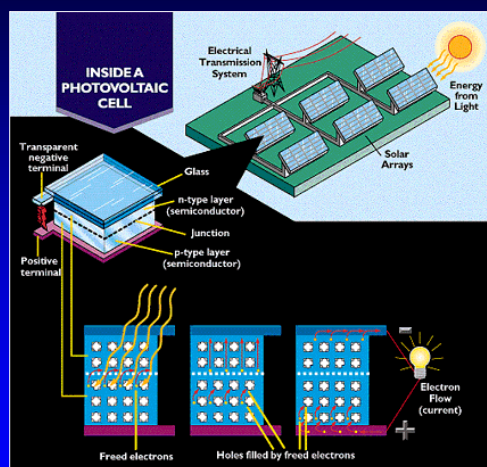
Photovoltaic Power



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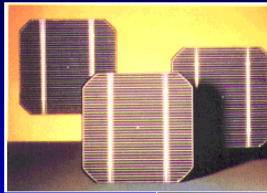
Photovoltaic Power



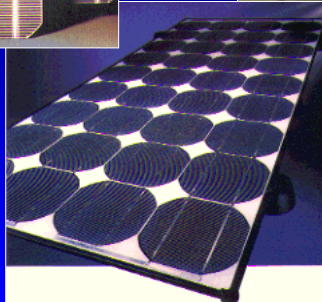
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Photovoltaic Power



Cells



Module



Array



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Photovoltaic Power

- direct-coupled DC loads
- AC loads that only operate while the sun is shining
- DC loads with battery storage
- AC loads with battery storage
- stand-alone isolated grid
- hybrid systems



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Photovoltaic Power



communications



lighting



battery charging



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Photovoltaic Power



The Thrift Shop at Fort Huachuca, AZ



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Photovoltaic Power



450 kWp PV Power Station at
Yuma Proving Ground, AZ



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Photovoltaic Power



Grid-connected PV system
demonstrated at the Pentagon



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Photovoltaic Power

- Renewable energy technology - no fuel costs
- No emissions, including noise and thermal
- No moving parts - greatly reduced maintenance
- Long service life, at least 20-25 years



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Photovoltaic Power

- Modular design capability allows power system sizes from calculator to large-scale utility grid support
- Many commercial products available, including packaged systems for specific applications
- Global infrastructure support
- Drawbacks - high initial costs \$5000/kW



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Photovoltaic Power

Further advancements include...

- Investigate and demonstrate thin film technologies, like cadmium-telluride and copper indium di-selenide, which have the potential of building-integrated applications, mass production, and significant cost reduction
- hybrids with fuel cells



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Photovoltaic Power



- Reduce greenhouse gas and other emissions
- Create high-technology jobs
- Keep the U.S. solar industry competitive



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Photovoltaic Power

- Developing a pool of existing federal lending and financing options
- Soliciting voluntary participation by state and local governments and groups
- Accelerating the use of solar energy systems on federal buildings - 20,000 by 2010
- Leveraging other financial support and incentives, both current and proposed



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Geothermal Power



Army installations in the Western U.S. are potential major consumers of electricity generated from a geothermal power plant, like the Navy's Coso facility pictured here.



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Geothermal Power



- 10% of the electricity used in the western states by 2020
- 7 million homes using geothermal energy by 2010
- Double the number of states with geothermal facilities to 8 by 2006



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Future Energy Strategies



Solar Regenerative PEM Fuel Cell
Joint Navy/NASA/JPL Project at Edwards AFB



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Questions?



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